Spatial and Temporal Relationships Between Total Nitrogen and Planktonic Chlorophyll in Long Island Sound

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Key Words: chlorophyll:nitrogen relationship, eutrophication, Long Island Sound, spatial and temporal trends, water temperature

Excess loading of nitrogen has been identified as a cause of excess primary production in many marine systems, including Long Island Sound. In particular, western Long Island Sound experiences significant seasonal hypoxia and anoxia attributed to excess nitrogen loading. We explored the relationship between nitrogen and phytoplankton, an important cause of anoxia in estuaries.

We used data collected by the Connecticut Department of Environmental Protection's Long Island Sound Water Quality Monitoring Program to examine spatial and temporal trends in concentrations of total nitrogen and chlorophyll in the water column and in the relationship between these two variables. Concentrations of both nitrogen and chlorophyll showed similar spatial gradients in Long Island Sound, with peak concentrations in the western Sound and much smaller concentrations in the eastern Sound. Summertime concentrations of total nitrogen declined modestly from 1995 to 2001. During this same period, summertime concentrations of chlorophyll showed much stronger temporal trends, with concentrations declining substantially in 1997-1999 compared with previous summers, followed by a large increase in 2000 and 2001. The spatial relationship between chlorophyll and total nitrogen reflected these changes (i.e., the slope of this relationship declined substantially from 1995-1999, only to increase dramatically in 2000). The summers of 1997-1999 were preceded by winters with somewhat warmer water temperatures than the preceding two and following two years. Other environmental variables examined (incident light intensity, river inflow, wind speed, total suspended solids) did not show patterns that correlated with the observed chlorophyll to nitrogen relationship. We will discuss mechanisms that could cause these temporal trends.

These results demonstrate that, while the relationship between phytoplankton biomass and nitrogen concentrations can be variable in the short term because of these confounding effects, it may be robust over longer periods. This has important implications for attempts to develop relationships between nitrogen loading to estuaries and ecological responses of these important water bodies. It suggests that we seek average responses over multiple years rather than in a single year. The apparent stability of the multiyear responses also suggests that it may be possible to develop load-response relationships that will facilitate USEPA's efforts to develop nutrient criteria for coastal embayments. This study relied on data from a monitoring program conducted by the State of Connecticut and demonstrates the benefits derived by using the wealth of information contained in publicly available databases.